US007798931B2

(12) **United States Patent**
Earhart

(10) **Patent No.: US 7,798,931 B2**
(45) **Date of Patent: Sep. 21, 2010**

(54) **MULTI-SPEED SPLIT DUAL CLUTCH TRANSMISSION**

(76) Inventor: **David Earl Earhart**, 8240 E. County Rd. 300 North, Brownsburg, IN (US) 46112

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 323 days.

(21) Appl. No.: **12/028,447**

(22) Filed: **Feb. 8, 2008**

(65) **Prior Publication Data**

US 2009/0203484 A1 Aug. 13, 2009

(51) **Int. Cl.**
F16H 3/44 (2006.01)

(52) **U.S. Cl.** **475/207**

(58) **Field of Classification Search** 475/207
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,128,681	B2 *	10/2006	Sugino et al.	475/218
2009/0036247	A1 *	2/2009	Earhart et al.	475/35
2009/0203482	A1 *	8/2009	Earhart	475/207
2009/0203483	A1 *	8/2009	Earhart	475/207

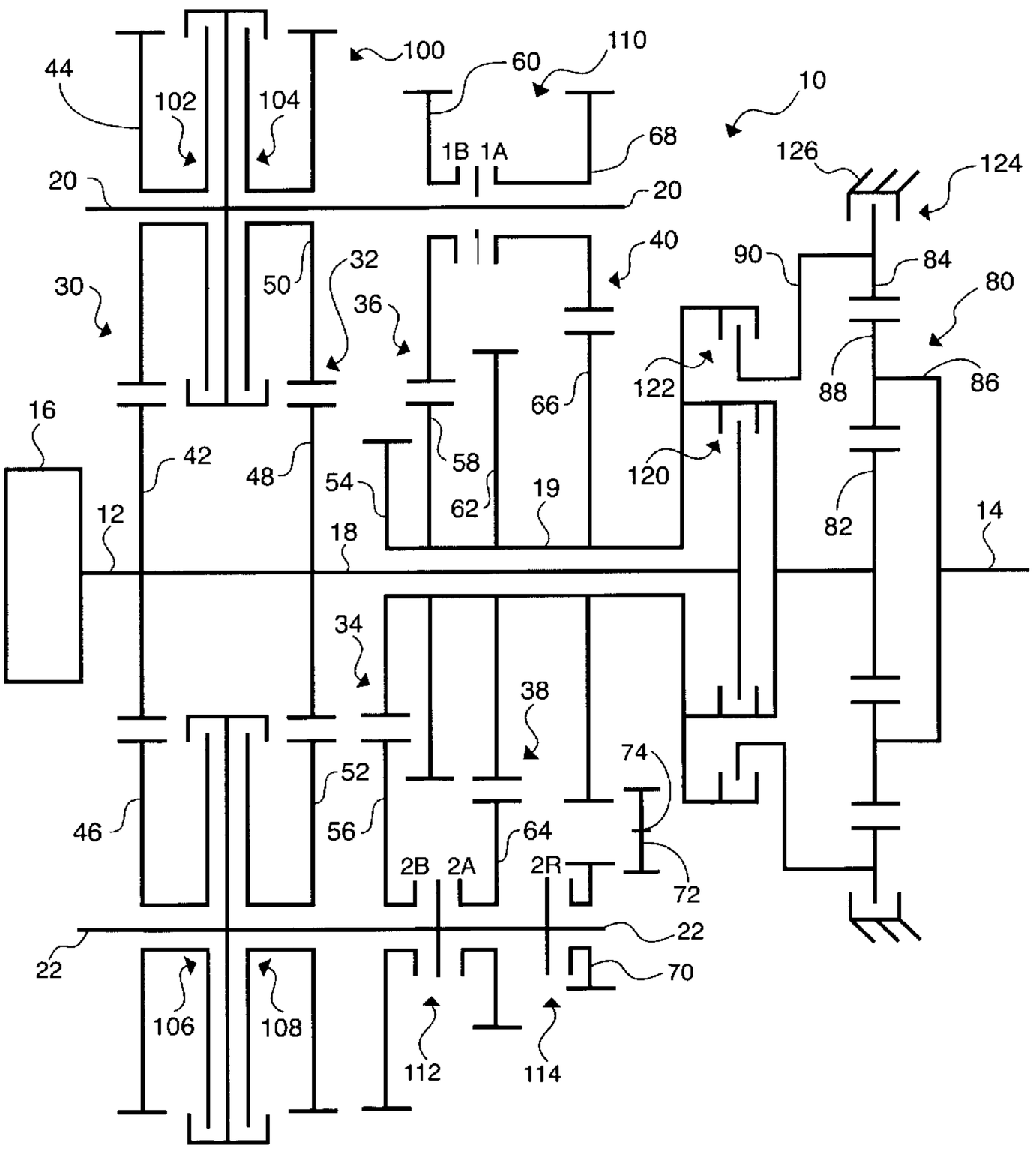
* cited by examiner

Primary Examiner—Dirk Wright

(57) **ABSTRACT**

A transmission is provided having an input member, an output member, a clutch assembly, two countershaft gearing arrangements, one planetary gear set, a plurality of interconnecting members, and a plurality of torque transmitting devices. Each of the countershaft gearing arrangements includes a plurality of co-planar gear sets. The torque transmitting devices include a combination of clutches, brakes, and synchronizers.

25 Claims, 2 Drawing Sheets



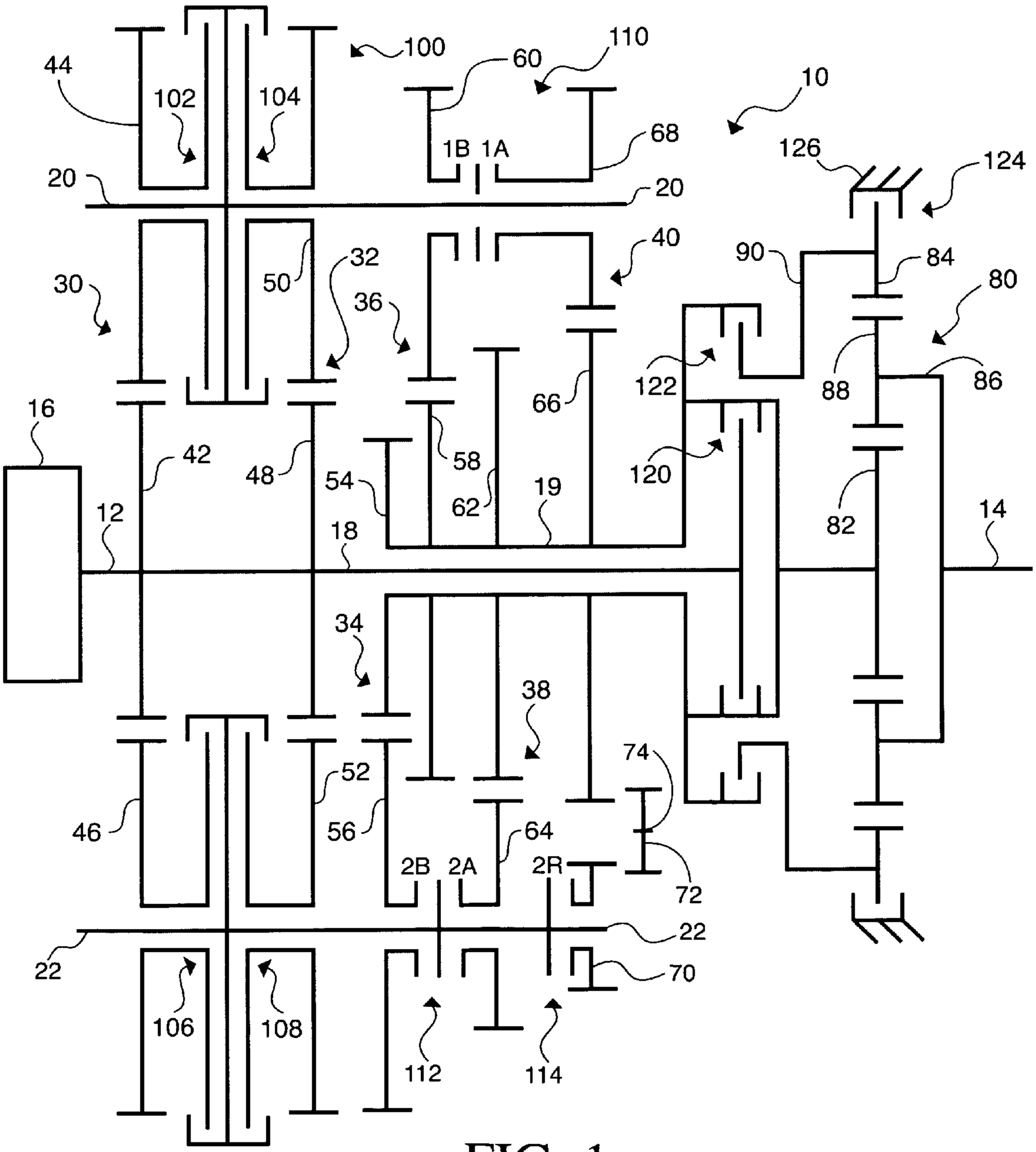

44
102
104
100
60
110
10
1B 1A
68
126
124
20
20
30
50
32
36
40
90
84
80
16
42
48
54
58
62
66
19
122
120
88
86
82
12
18
14
34
38
74
52
46
56
64
2B 2A
2R
72
22
22
70
106
108
112
114

FIG. 1

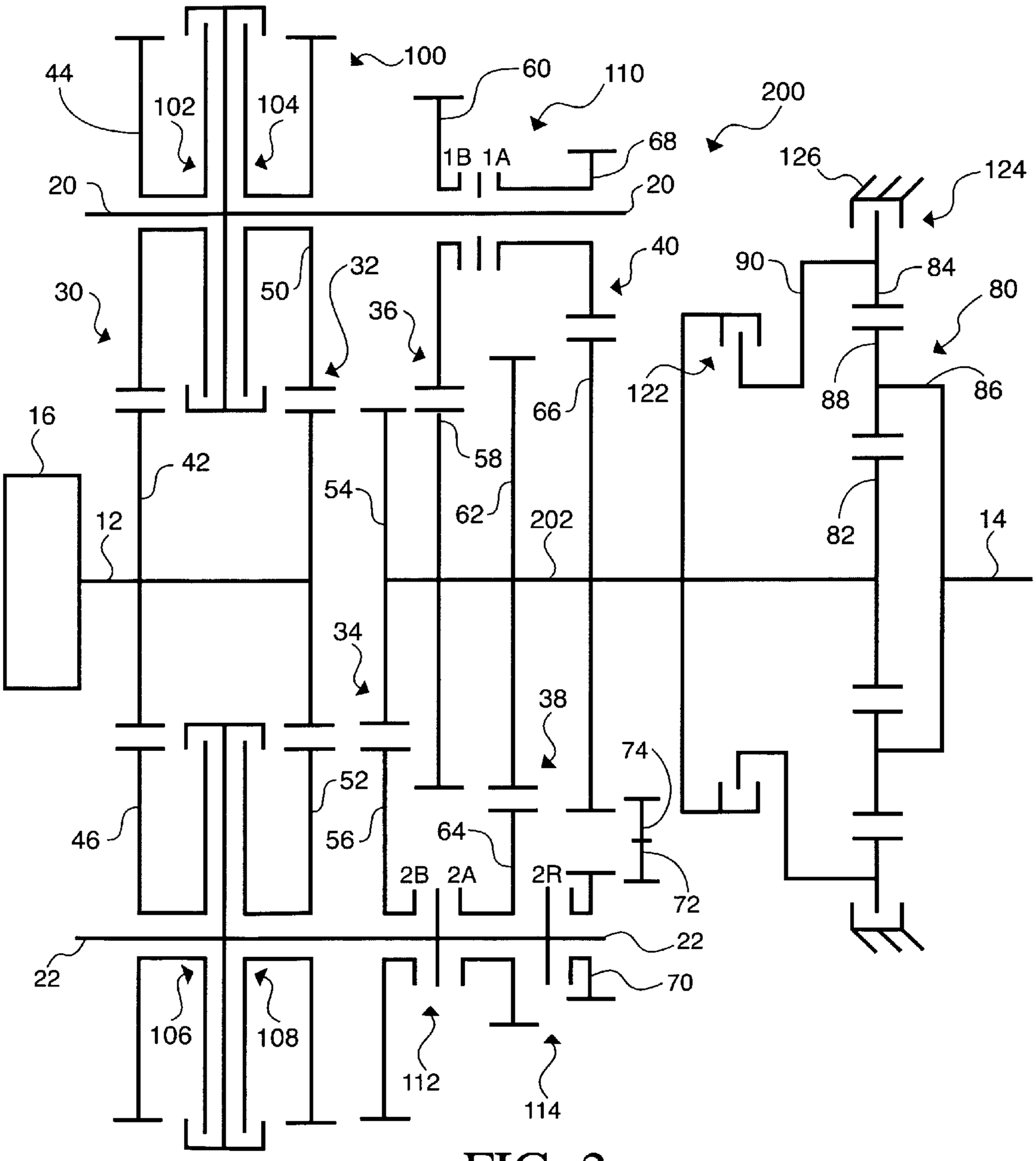

44
102
104
100
60
110
200
1B
1A
68
126
124
20
20
30
50
32
36
40
90
84
80
16
42
66
122
88
86
58
54
62
202
12
82
14
34
38
74
52
46
56
64
2B
2A
2R
72
22
22
70
106
108
112
114

FIG. 2

MULTI-SPEED SPLIT DUAL CLUTCH TRANSMISSION

FIELD

The present disclosure relates to transmissions, and more particularly to a multiple speed split dual clutch transmission having dual countershafts.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may or may not constitute prior art.

A typical multi-speed, dual clutch transmission employs a plurality of clutches to achieve a plurality of forward and reverse gear ratios. These dual clutch transmissions are typically employed in front-wheel drive applications. Additionally, a slipping clutch is employed to transmit launch torque from an engine to the transmission in order to achieve a high power-to-weight ratio that is desirable in non-commercial vehicles.

While useful for its intended purpose, these conventional multi-speed dual clutch transmissions do not have the range of torque and available gear ratios necessary to be employed in commercial vehicles or trucks. Additionally, the addition of clutches, brakes, and gear sets to achieve these gear ratios and torque ranges may result in inefficient or undesirable transmission weights and sizes. Accordingly, there is a need in the art for a transmission having improved packaging while providing desirable gear ratios and torque ranges.

SUMMARY

The present invention provides a transmission having an input member, an output member, a split dual clutch assembly, two countershaft gearing arrangements, one planetary gear set, a plurality of interconnecting members, and a plurality of torque transmitting devices. Each of the countershaft gearing arrangements includes a plurality of co-planar gear sets. The torque transmitting devices include a combination of clutches, brakes, and synchronizers.

In one aspect of the present invention the torque transmitting devices include six clutches, one brake, and three synchronizers to provide at least seventeen forward gear ratios.

In another aspect of the present invention the torque transmitting devices include five clutches, one brake, and three synchronizers to provide at least sixteen forward gear ratios.

In still another aspect of the present invention the countershafts are radially outward from and parallel to the input member.

In still another aspect of the present invention the planetary gear set is co-axial with the input member.

In still another aspect of the present invention the transmission includes a torque converter continuously connected with the input member.

In still another aspect of the present invention the split dual clutch assembly includes a first and second clutch for selectively connecting the input member with a first countershaft and a third and fourth clutch for selectively connecting the input member with a second countershaft.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

FIG. **1** is a diagrammatic view of a seventeen speed embodiment of a transmission according to the principles of the present invention; and

FIG. **2** is a diagrammatic view of a sixteen speed embodiment of the transmission according to the principles of the present invention.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses.

With reference to FIG. **1**, a stick diagram presents a schematic layout of a multi-speed transmission for use in a motor vehicle, generally indicated by reference number **10**. The transmission **10** is preferably a longitudinal split dual clutch transmission. The transmission **10** includes an input shaft or member **12** and an output shaft or member **14**. Those skilled in the art will appreciate that the input and output members **12**, **14** may be components other than shafts without departing from the scope of the present invention. In the example provided, the input member **12** is continuously connected to a turbine of a torque converter **16**. The output member **14** is continuously connected with a final drive unit or transfer case (not shown) in the motor vehicle.

The transmission **10** further includes interconnecting shafts, countershafts, co-planar intermeshing gear sets, and selectively engagable synchronizers and clutches as will be described herein. For example, the transmission **10** includes a first shaft or interconnecting member **18**, a second shaft or interconnecting member **19**, a first layshaft or countershaft **20**, and a second layshaft or countershaft **22**. The first interconnecting member **18** is rotatingly coupled to the input member **12**. The second interconnecting member **19** is preferably a sleeve shaft that is at least partially coaxial with the first interconnecting member **18**. The countershafts **20**, **22** are both spaced radially outward from and parallel with the input member **12**, the output member **14**, and the interconnecting members **18**, **19**.

The transmission **10** includes a plurality of co-planar or spur gear sets including a first gear set **30**, a second gear set **32**, a third gear set **34**, a fourth gear set **36**, a fifth gear set **38**, and a sixth gear set **40**. The first gear set **30** includes a gear **42**, a gear **44**, and a gear **46**. Gear **42** is connected for common rotation with the input shaft **12** and intermeshed with gear **44** and gear **46**. Gear **44** is rotatable about and selectively connectable with the first countershaft **20**. Gear **46** is rotatable about and selectively connectable with the second countershaft **22**.

The second gear set **32** includes a gear **48**, a gear **50**, and a gear **52**. Gear **48** is connected for common rotation with the input member **12** and the first interconnecting member **18** and is intermeshed with gear **50** and gear **52**. Gear **50** is rotatable about and selectively connectable with the first countershaft **20**. Gear **52** is rotatable about and selectively connectable with the second countershaft **22**.

The third gear set **34** includes a gear **54** and a gear **56**. Gear **54** is connected for common rotation with the second interconnecting member **19** and is intermeshed with gear **56**. Gear **56** is rotatable about and selectively connectable with the second countershaft **22**.

The fourth gear set **36** includes a gear **58** and a gear **60**. Gear **58** is connected for common rotation with the second interconnecting member **19** and is intermeshed with gear **60**. Gear **60** is rotatable about and selectively connectable with the first countershaft **20**.

The fifth gear set **38** includes a gear **62** and a gear **64**. Gear **62** is connected for common rotation with the second interconnecting member **19** and is intermeshed with gear **64**. Gear **64** is rotatable about and selectively connectable with the second countershaft **22**.

The sixth gear set **40** includes a gear **66**, a gear **68**, and a gear **70**. Gear **66** is connected for common rotation with the second interconnecting member **19** and is intermeshed with gear **68** and an idler gear **72**. Gear **68** is rotatable about and selectively connectable with the first countershaft **20**. The idler gear **72** is connected for common rotation with an independent shaft or pinion **74**. The idler gear **72** is intermeshed with gear **70**. Gear **70** is rotatable about and selectively connectable with the second countershaft **22**.

The transmission **10** further includes a high/low splitter gear set **80** located between the members **12**, **18**, and **19** and the output shaft **14**. The splitter gear set **80** is preferably a simple planetary gear set having a sun gear member **82**, a ring gear member **84**, and a planet carrier member **86** which rotatably supports a set of pinion gears **88** which intermesh with both the sun gear member **82** and the ring gear member **84**. The sun gear member **82** is connected for common rotation with the second interconnecting member **19**. The ring gear member **84** is connected for common rotation with a third shaft or interconnecting member **90**. The planet carrier member **86** is connected for common rotation with the output member **14**.

The transmission **10** also includes a split dual clutch assembly **100** for selectively coupling the input member **12** to one of the first and second countershafts **20**, **22**. More specifically, the split dual clutch assembly **100** includes a first clutch **102**, a second clutch **104**, a third clutch **106**, and a fourth clutch **108**. The first clutch **102** is selectively engageable to connect gear **44** of the first gear set **30** with the first countershaft **20**. The second clutch **104** is selectively engageable to connect gear **50** of the second gear set **32** with the first countershaft **20**. The third clutch **106** is selectively engageable to connect gear **46** of the first gear set **30** with the second countershaft **22**. The fourth clutch **108** is selectively engageable to connect gear **52** of the second gear set **32** with the second countershaft **22**. In the example provided, the first and third clutches **102**, **106** are coplanar and radially offset from the input member **12** and the second and fourth clutches **104**, **108** are coplanar and radially offset from the input member **12**. However, it should be appreciated that the clutches **102**, **104**, **106**, **108** may be in various other positions relative to one another without departing from the scope of the present invention.

A plurality of coupling mechanisms including a first synchronizer **110**, a second synchronizer **112**, and a third synchronizer **114** allow for selective interconnection of the gears **56**, **60**, **64**, **68**, and **70** with the countershafts **20**, **22**. The synchronizers **110**, **112**, **114** generally include a shift fork (not shown) that is bi-directionally translated by an actuator (not shown) into at least two engaged positions and a neutral or disengaged position. For example, the first synchronizer **110** may be translated to the left (position **1**B in FIG. **1**) to synchronize the speed of the first countershaft **20** with the speed of gear **60** and couple it thereto or moved to the right (position **1**A in FIG. **1**) to synchronize the speed of the first countershaft **20** with the speed of gear **68** and couple it thereto. The second synchronizer **112** may be translated to the left (position **2**B in FIG. **1**) to synchronize the speed of the second countershaft **22** with the speed of gear **56** and couple it thereto or moved to the right (position **2**A in FIG. **1**) to synchronize the speed of the second countershaft **22** with the speed of gear **64** and couple it thereto. The third synchronizer **114** may be translated to the right (position **2**R in FIG. **1**) to synchronize the speed of the second countershaft **22** with the speed of gear **70** and couple it thereto.

A plurality of torque-transmitting devices including a fifth clutch **120**, a sixth clutch **122**, and a brake **124** allow for selective interconnection of the interconnecting members **18**, **19**, **90** with the members of the high/low splitter gear set **80** and a ground, stationary element, or a transmission housing **126**. For example, the fifth clutch **120** is selectively engageable to connect the first interconnecting member **18** with the second interconnecting member **19**. The sixth clutch **122** is selectively engageable to connect the second interconnecting member **19** with the third interconnecting member **90**. The brake **124** is selectively engageable to connect the third interconnecting member **90** and the ring gear member **84** with a ground or the transmission housing **126** in order to restrict the ring gear member **84** from rotating relative to the ground or the transmission housing **126**. The clutches **120**, **122** and the brake **124** are preferably hydraulically actuated friction clutches as is known in the art. Additionally, the fifth clutch **120** is preferably concentric with the sixth clutch **122** and radially inward therefrom in order to reduce the size of the transmission **10**.

It will be appreciated that the transmission **10** is capable of transmitting torque from the input member **12** to the output member **14** in at least seventeen forward speed or torque ratios and at least four reverse speed or torque ratios. Each forward and reverse speed or torque ratio is attained by engagement of one or more of the torque-transmitting devices (i.e. first synchronizer **110**, second synchronizer **112**, third synchronizer **114**, first clutch **102**, second clutch **104**, third clutch **106**, fourth clutch **108**, fifth clutch **120**, sixth clutch **122**, and brake **124**), as will be explained below. Chart 1 is a truth table presenting the various combinations of torque-transmitting devices that are activated or engaged to achieve the various gear states. In the particular example provided, "**1**A", "**1**B", "**2**A", "**2**B", and "**2**R" refer to the positions of the synchronizers **110**, **112**, **114** as described above and illustrated in FIG. **1**. A blank in the column of the synchronizers **110**, **112**, **114** indicates that the synchronizers **110**, **112**, **114** may be in any position, including a neutral or disengaged position. An "X" indicates that the torque transmitting element is engaged or activated for the given speed ratio.

CHART 1

	TORQUE TRANSMITTING ELEMENTS									
Speed Ratio	102	104	106	108	120	124	122	110	112	114
1	X					X		1A		
2			X			X			2A	
3		X				X		1B		
4				X		X			2B	
5	X					X		1A		

CHART 1-continued

	TORQUE TRANSMITTING ELEMENTS									
Speed Ratio	102	104	106	108	120	124	122	110	112	114
6			X			X			2A	
7		X				X		1B		
8				X		X			2B	
9	X						X	1A		
10			X				X		2A	
11		X					X	1B		
12				X			X		2B	
13	X						X	1A		
14			X				X		2B	
15		X					X	1A		
16					X					
17				X			X		2B	
R1			X			X				2R
R2				X		X				2R
R3			X				X			2R
R4				X			X			2R

For example, to establish first gear, the first clutch **102** and the brake **124** are engaged or activated and the first synchronizer **110** is in the **1**A position. Likewise, the reverse gears and the seventeen forward ratios are achieved through different combinations of clutch and brake engagement and synchronizer position, as shown in Chart 1.

Chart 2 is a truth table presenting an alternate embodiment of the various combinations of torque-transmitting devices that are activated or engaged to achieve the various gear states. In the particular example provided, "**1**A", "**1**B", "**2**A", "**2**B", and "**2**R" refer to the positions of the synchronizers **110**, **112**, **114** as described above and illustrated in FIG. **1**. A blank in the column of the synchronizers **110**, **112**, **114** indicates that the synchronizers **110**, **112**, **114** may be in any position, including a neutral or disengaged position. An "X" indicates that the torque transmitting element is engaged or activated for the given speed ratio.

CHART 2

	TORQUE TRANSMITTING ELEMENTS									
Speed Ratio	102	104	106	108	120	124	122	110	112	114
1	X					X		1A		
2		X				X		1A		
3			X			X			2A	
4				X		X			2A	
5	X					X		1B		
6		X				X		1B		
7			X			X			2B	
8				X		X			2B	
9	X						X	1A		
10		X					X	1A		
11			X				X		2A	
12				X			X		2A	
13	X						X	1B		
14		X					X	1B		
15			X				X		2B	
16					X					
17				X			X		2B	
R1			X			X				2R
R2				X		X				2R
R3			X				X			2R
R4				X			X			2R

For example, to establish first gear, the first clutch **102** and the brake **124** are engaged or activated and the first synchronizer **110** is in the **1**A position. Likewise, the reverse gears and the seventeen forward ratios are achieved through different combinations of clutch and brake engagement and synchronizer position, as shown in Chart 2.

Turning now to FIG. **2**, an alternate embodiment of the transmission **10** is shown and generally indicated by reference number **200**. The transmission **200** is similar to the transmission **10** and accordingly like parts are indicated by like reference numbers. However, the transmission **200** does not include the fifth clutch **120**. Additionally, the first interconnecting member **18** and the second interconnecting member **19** have been replaced by a fourth shaft or interconnecting member **202**. The fourth interconnecting member **202** is coupled for common rotation with the gears **54**, **58**, **62**, **66**, the sixth clutch **122**, and the sun gear **82**. Additionally, the fourth interconnecting member **202** is not directly coupled to the input member **12**.

The transmission **200** is a 16-speed transmission with overdrive and is operable to provide at least 16 forward speed or torque ratios and at least four reverse speed or torque ratios.

Chart 3 is a truth table presenting the various combinations of the torque-transmitting devices that are activated or engaged to achieve the sixteen forward speed or torque ratios and the four reverse speed or torque ratios in the 16-speed transmission **200**. In the particular example provided, "**1**A", "**1**B", "**2**A", "**2**B", and "**2**R" refer to the positions of the synchronizers **110**, **112**, **114** as described above and illustrated in FIG. **2**. A blank in the column of the synchronizers **110**, **112**, **114** indicates that the synchronizers **110**, **112**, **114** may be in any position, including a neutral or disengaged position. An "X" indicates that the torque transmitting element is engaged or activated for the given speed ratio.

CHART 3

Speed	TORQUE TRANSMITTING ELEMENTS								
Ratios	102	104	106	108	124	122	110	112	114
1	X				X		1A		
2		X			X		1A		
3			X		X			2A	
4				X	X			2A	
5	X				X		1B		
6		X			X		1B		
7			X		X			2B	
8				X	X			2B	
9	X					X	1A		
10		X				X	1A		
11			X			X		2A	
12				X		X		2A	
13	X					X	1B		
14		X				X	1B		
15			X			X		2B	
16				X		X		2B	
R1			X		X				2R
R2				X	X				2R
R3			X			X			2R
R4				X		X			2R

For example, to establish first gear, the first clutch **102** and the brake **124** are engaged or activated and the first synchronizer **110** is in the **1**A position. Likewise, the reverse gears and the sixteen forward ratios are achieved through different combinations of clutch and brake engagement and synchronizer position, as shown in Chart 3.

Chart 4 is a truth table presenting an alternate embodiment of the various combinations of torque-transmitting devices that are activated or engaged to achieve the various gear states. In the particular example provided, "**1**A", "**1**B", "**2**A", "**2**B", and "**2**R" refer to the positions of the synchronizers **110**, **112**, **114** as described above and illustrated in FIG. **2**. A blank in the column of the synchronizers **110**, **112**, **114** indicates that the synchronizers **110**, **112**, **114** may be in any position, including a neutral or disengaged position. An "X" indicates that the torque transmitting element is engaged or activated for the given speed ratio.

CHART 4

Speed	TORQUE TRANSMITTING ELEMENTS								
Ratios	102	104	106	108	124	122	110	112	114
1	X				X		1A		
2			X		X			2A	
3		X			X		1B		
4				X	X			2B	
5	X				X		1A		
6			X		X			2A	
7		X			X		1B		
8				X	X			2B	
9	X					X	1A		

CHART 4-continued

Speed	TORQUE TRANSMITTING ELEMENTS								
Ratios	102	104	106	108	124	122	110	112	114
10			X			X		2A	
11		X				X	1B		
12				X		X		2B	
13	X					X	1A		
14			X			X		2B	
15		X				X	1A		
16				X		X		2B	
R1			X		X				2R
R2				X	X				2R
R3			X			X			2R
R4				X		X			2R

For example, to establish first gear, the first clutch **102** and the brake **124** are engaged or activated and the first synchronizer **110** is in the **1**A position. Likewise, the reverse gears and the sixteen forward ratios are achieved through different combinations of clutch and brake engagement and synchronizer position, as shown in Chart 4.

The description of the invention is merely exemplary in nature and variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

What is claimed is:

1. A transmission comprising:

an input member;

an output member;

a first gearing arrangement including a first gear set, a second gear set, a third gear set, a fourth gear set, and a first countershaft, wherein the first gear set, the second gear set, the third gear set, and the fourth gear set are selectively connectable to the first countershaft, and wherein the input member is continuously interconnected with the first gear set and the second gear set;

a second gearing arrangement including the first gear set, the second gear set, the fourth gear set, a fifth gear set, a sixth gear set, and a second countershaft, wherein the first gear set, the second gear set, the fourth gear set, the fifth gear set, and the sixth gear set are selectively connectable to the second countershaft;

a planetary gear set having a first member, a second member, and a third member;

a first interconnecting member continuously interconnected to the third, fourth, fifth, and sixth gear sets and to the first member of the planetary gear set;

a second interconnecting member continuously interconnected to the third member of the planetary gear set;

a clutch assembly selectively engageable to interconnect one of the first gear set and the second gear set with one of the first countershaft and the second countershaft;

three synchronizers for selectively coupling one of the third, fourth, fifth, and sixth gear sets with one of the first and second countershafts;

three torque-transmitting devices selectively engageable to interconnect one of the input member, first interconnecting member, and second interconnecting member with another of the input member, first interconnecting member, second interconnecting member, and a stationary element; and

wherein the torque-transmitting devices and synchronizers are selectively engageable in combinations of at least three to establish at least seventeen forward speed ratios

and at least four reverse speed ratio between the input member and the output member.

2. The transmission of claim **1** wherein the first countershaft is located radially outward from and parallel to the input member.

3. The transmission of claim **2** wherein the second countershaft is located radially outward from and parallel to the input member.

4. The transmission of claim **1** further comprising a torque converter continuously connected with the input member.

5. The transmission of claim **1** wherein the clutch assembly includes a first clutch for selectively connecting the first gear set with the first countershaft.

6. The transmission of claim **5** wherein the clutch assembly includes a second clutch for selectively connecting the second gear set with the first countershaft.

7. The transmission of claim **6** wherein the clutch assembly includes a third clutch for selectively connecting the first gear set with the second countershaft.

8. The transmission of claim **7** wherein the clutch assembly includes a fourth clutch for selectively connecting the second gear set with the second countershaft.

9. The transmission of claim **1** wherein a first of the three torque-transmitting devices selectively connects the input member with the first interconnecting member.

10. The transmission of claim **9** wherein a second of the three torque-transmitting devices selectively connects the first interconnecting member with the second interconnecting member.

11. The transmission of claim **10** wherein a third of the three torque-transmitting devices selectively connects the third member of the planetary gear set with the stationary element.

12. The transmission of claim **1** wherein a first of the three synchronizers selectively connects one of the third gear set and the fourth gear set to the first countershaft.

13. The transmission of claim **12** wherein a second of the three synchronizers selectively connects one of the fifth gear set and the sixth gear set to the second countershaft.

14. The transmission of claim **13** wherein a third of the three synchronizers selectively connects the fourth gear set to the second countershaft.

15. The transmission of claim **14** wherein the first, second, third, fourth, fifth, and sixth gear sets are co-planar gear sets each including at least a first gear intermeshed with a second gear.

16. The transmission of claim **15** wherein a plurality of the first gears are continuously interconnected with the second interconnecting member and a plurality of the second gears are continuously interconnected with one of the first and second countershafts.

17. The transmission of claim **16** wherein the fourth gear set includes a third gear selectively connectable to the second countershaft, the third gear intermeshed with an idler gear, the idler gear intermeshed with the first gear of the fourth gear set.

18. The transmission of claim **1** wherein the first member of the planetary gear set is a sun gear member, the second member of the planetary gear set is a planet carrier member, and the third member of the planetary gear set is a ring gear member.

19. The transmission of claim **1** wherein the output member is continuously connected to the second member of the planetary gear set.

20. A transmission comprising:

an input member;

an output member;

a first, second, and fourth gear set each having a first gear member, a second gear member, and a third gear member, wherein the input member is continuously interconnected with the first gear member of the first gear set and the first gear member of the second gear set;

a third, fifth, and sixth gear set each having a first gear member and a second gear member;

a first countershaft selectively connectable with the second gear members of the first, second, third, and fourth gear sets;

a second countershaft selectively connectable with the third gear members of the first, second, and fourth gear sets and with the second gear members of the fifth and sixth gear sets;

a planetary gear set having a first member, a second member, and a third member;

a first interconnecting member continuously interconnected to the first members of the third, fourth, fifth, and sixth gear sets and to the first member of the planetary gear set;

a second interconnecting member continuously interconnected to the third member of the planetary gear set;

a clutch assembly selectively engageable to interconnect one of the first gear set and the second gear set with one of the first countershaft and the second countershaft;

three synchronizers for selectively coupling one of the third, fourth, fifth, and sixth gear sets with one of the first and second countershafts;

three torque-transmitting devices selectively engageable to interconnect one of the input member, first interconnecting member, and second interconnecting member with another of the input member, first interconnecting member, second interconnecting member, and a stationary element; and

wherein the torque-transmitting devices and synchronizers are selectively engageable in combinations of at least three to establish at least seventeen forward speed ratios and at least four reverse speed ratio between the input member and the output member.

21. The transmission of claim **20** wherein a first of the three synchronizers selectively connects one of the second gear member of the third gear set and the second gear member of the fourth gear set with the first countershaft, a second of the three synchronizers selectively connects one of the second gear member of the fifth gear set and the second gear member of the sixth gear set to the second countershaft, and a third of the three synchronizers selectively connects the third member of the fourth gear set to the second countershaft.

22. The transmission of claim **20** wherein the clutch assembly includes a first clutch for selectively connecting the second gear member of the first gear set with the first countershaft, a second clutch for selectively connecting the second gear member of the second gear set with the first countershaft, a third clutch for selectively connecting the third gear member of the first gear set with the second countershaft, a fourth clutch for selectively connecting the third gear member of the second gear set with the second countershaft, and wherein a first of the three torque-transmitting devices selectively connects the input member with the first interconnecting member, a second of the three torque-transmitting devices selectively connects the first interconnecting member with the second interconnecting member, and a third of the three torque-transmitting devices selectively connects the third member of the planetary gear set with the stationary element.

23. A transmission comprising:

an input member;

an output member;

a first gearing arrangement including a first gear set, a second gear set, a third gear set, a fourth gear set, and a

first countershaft, wherein the first gear set, the second gear set, the third gear set, and the fourth gear set are selectively connectable to the first countershaft, and wherein the input member is continuously interconnected with the first gear set and the second gear set;

a second gearing arrangement including the first gear set, the second gear set, the fourth gear set, a fifth gear set, a sixth gear set, and a second countershaft, wherein the first gear set, the second gear set, the fourth gear set, the fifth gear set, and the sixth gear set are selectively connectable to the second countershaft;

a planetary gear set having a sun gear, a carrier member, and a ring gear;

a first interconnecting member continuously interconnected to the third, fourth, fifth, and sixth gear sets;

a second interconnecting member continuously interconnected to the ring gear of the planetary gear set;

a first clutch for selectively connecting the first gear set with the first countershaft;

a second clutch for selectively connecting the second gear set with the first countershaft;

a third clutch for selectively connecting the first gear set with the second countershaft;

a fourth clutch for selectively connecting the second gear set with the second countershaft;

a fifth clutch for selectively connecting the input member with the first interconnecting member;

a sixth clutch for selectively connecting the first interconnecting member with the second interconnecting member;

a brake for selectively connecting the ring gear of the planetary gear set with a stationary element;

a first synchronizer for selectively connecting one of the third gear set and the fourth gear set to the first countershaft;

a second synchronizer for selectively connecting one of the fifth gear set and the sixth gear set to the second countershaft;

a third synchronizer for selectively connecting the fourth gear set to the second countershaft; and

wherein the clutches, brake, and synchronizers are selectively engageable in combinations of at least three to establish at least seventeen forward speed ratios and at least four reverse speed ratio between the input member and the output member.

24. A transmission comprising:

an input member;

an output member;

a first gearing arrangement including a first gear set, a second gear set, a third gear set, a fourth gear set, and a first countershaft, wherein the first gear set, the second gear set, the third gear set, and the fourth gear set are selectively connectable to the first countershaft, and wherein the input member is continuously interconnected with the first gear set and the second gear set;

a second gearing arrangement including the first gear set, the second gear set, the fourth gear set, a fifth gear set, a sixth gear set, and a second countershaft, wherein the first gear set, the second gear set, the fourth gear set, the fifth gear set, and the sixth gear set are selectively connectable to the second countershaft;

a planetary gear set having a first member, a second member, and a third member;

a first interconnecting member continuously interconnected to the third, fourth, fifth, and sixth gear sets and to the first member of the planetary gear set;

a second interconnecting member continuously interconnected to the third member of the planetary gear set;

a clutch assembly selectively engageable to interconnect one of the first gear set and the second gear set with one of the first countershaft and the second countershaft;

three synchronizers for selectively coupling one of the third, fourth, fifth, and sixth gear sets with one of the first and second countershafts;

two torque-transmitting devices selectively engageable to interconnect one of the first interconnecting member and second interconnecting member with another of the first interconnecting member, second interconnecting member, and a stationary element; and

wherein the torque-transmitting devices and synchronizers are selectively engageable in combinations of at least three to establish at least sixteen forward speed ratios and at least four reverse speed ratio between the input member and the output member.

25. A transmission comprising:

an input member;

an output member;

a first gearing arrangement including a first gear set, a second gear set, a third gear set, a fourth gear set, and a first countershaft, wherein the first gear set, the second gear set, the third gear set, and the fourth gear set are selectively connectable to the first countershaft, and wherein the input member is continuously interconnected with the first gear set and the second gear set;

a second gearing arrangement including the first gear set, the second gear set, the fourth gear set, a fifth gear set, a sixth gear set, and a second countershaft, wherein the first gear set, the second gear set, the fourth gear set, the fifth gear set, and the sixth gear set are selectively connectable to the second countershaft;

a planetary gear set having a sun gear, a carrier member, and a ring gear, wherein the output member is continuously connected with the carrier member;

a first interconnecting member continuously interconnected to the third, fourth, fifth, and sixth gear sets and to the sun gear of the planetary gear set;

a second interconnecting member continuously interconnected to the ring gear of the planetary gear set;

a first clutch for selectively connecting the first gear set with the first countershaft;

a second clutch for selectively connecting the second gear set with the first countershaft;

a third clutch for selectively connecting the first gear set with the second countershaft;

a fourth clutch for selectively connecting the second gear set with the second countershaft;

a fifth clutch for selectively connecting the first interconnecting member with the second interconnecting member;

a brake for selectively connecting the ring gear of the planetary gear set with a stationary element;

a first synchronizer for selectively connecting one of the third gear set and the fourth gear set to the first countershaft;

a second synchronizer for selectively connecting one of the fifth gear set and the sixth gear set to the second countershaft;

a third synchronizer for selectively connecting the fourth gear set to the second countershaft; and

wherein the clutches, brake, and synchronizers are selectively engageable in combinations of at least three to establish at least sixteen forward speed ratios and at least four reverse speed ratio between the input member and the output member.

* * * * *